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METHODOLOGY FOR EVALUATION OF BREAD MAKING TOOLS – A REVIEW

P. RAJYA LAKSHMI[1] & D. RATNA KUMARI[2]

[1]PG Student Department of Resource Management and Consumer Science, College of Home Science, College of Home Science, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

[2]Associate Professor, Department of Resource Management and Consumer Science, College of Home Science, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India

ABSTRACT

Indian bread making tools are a part of hand tools. Rolling pin and rolling board are used for making Indian breads. Indian breads are made as flat bread or pastry on a rolling board with the rolling pin. In roti making process, there were many disadvantages like dough sticking to the pin and board, inefficiency with the comfortability issues of the tools, instability of the board etc; which leads to the drudgery of the user. In order to find the drudgery of the users who used bread making tools the review on methodologies for evaluation of bread making tools was carried out. From the review, it shows that different parameters relating to hand - hand tool interaction are required to be considered for evaluating the design of hand tools. The parameters to be considered in relation to the hand tool are its physical features and for hand are its Biomechanical features. The physical and biomechanical features are interrelated. If better fitted hand tools are to be designed the knowledge of hand dimension is required.

KEYWORDS: Anthropometry, Grip strength, Flexicurve, Heart Rate & Energy Expenditure

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Review Article

INTRODUCTION

Indian bread making tools come under the major section of hand tools as classified based on purpose by Frievalds (1997). An instrument made of metal which is been handled by hand for operating or using is called a hand tool (Oxford dictionary, 2004); or a device which is used in manual operation or any mechanical works to complete the user's task by hand (Lifco dictionary, 2004). Indian bread making tools are a part of hand tools. Rolling pin and rolling board are used for making Indian breads. Indian breads are made as flat bread or pastry on a rolling board with the rolling pin (Heloise, 1963).

Thomson (1978) in the study "Rolling pin construction" mentioned that the rolling of pastry crust is a flow procedure. In this process the dough is made into ball and is flattened on the circular flat board which is called rolling board with the pin. During this procedure, the dough gets stick to the board and also the pin. To avoid this, the flour is added which changes the texture of the bread and also the quality. Beyond this the tools which were not designed eith ergonomic considerations of the user, the tools are proning drudgery issues on the user related to the handle of pin, weight of pin and board, instability of board etc. This issues raise many disadvantages:

- More time consumption and less efficiency to complete the job.
- Flour is been added before and after making a dough flattened for not sticking to pin and board, which changes the texture of bread

In the improvisation of technology many gadgets and many mechanized tools had come into market to simplify the users task or job for which even ergonomic conditions of the tools also has to be considered. While doing any work, different undesirable and un-ergonomic tools to which people become adaptable that effect their health and psychology. To avoid such hazards ergonomic evaluation of hand tools is necessary (Greenberg & Chaffin, 1997). So, there is a need to consider the methods of evaluation for Bread making tools accordingly the review was collected.

METHODOLOGIES FOR EVALUATION OF BREAD MAKING TOOLS

The evaluation of hand tools ergonomically can be carried through different methods. Different methodologies have given results in different ways in different directions and at different angles. Various researchers have adopted different methodologies to evaluate hand tools ergonomically.

Anthropometry

While designing any user based tool, one of the vital issues to be considered is Anthropometry of the user. To design better fitted hand tools, knowledge of hand dimensions is essential (Lewis and Narayanan, 1993; Okunribido, 2000).

Static Dimensions

- **Length of Palm Stretch**: Sliding calipers is used to measure from the middle bottom to the tip of the middle finger using sliding calipers (Ray, 1990).
- **Circumference of Handle:** User has to hold the cone tightly with the maximum largest grip possibility with ends of the fingers. The circumference of the user fingers joining tips will be taken and noted by using sliding callipers (Clauser and Nguyen, 1993).
- **Palm Index**: handles of the pins were painted and asked the subject to hold the handle of the rolling pin as they regularly used to while doing work. After that the subjects were asked to give their painted impression on the white paper and the outlines of the impressions were marked and measured on the white paper. The total palm area was measured by measuring the palm, length wise and width wise and area was calculated.

  Palm index, then was calculated using the following formula-

$$\text{Palm Index} = \frac{\text{Effective palm area}}{\text{Total Palm area}} \times 100$$

Sliding calipers and measuring tape are the equipment used to conduct this experiment. It helps us to find out the maximum space utilized by the user using the handle.

Repetition may seem obvious since the typing task is based on rapid repeated finger movement - however it is often not this finger motion that is the primary cause of problems. Not that the motion occurring at the finger level is unimportant – in fact without the repetitive finger action injury would be far less frequent. With perfect technique, even with the repetition, injury would seldom occur. Most of the other ergonomic risk factors are minimal. More often repetition based injuries have to do with the angle of work, often with the wrist or thumb. Even repetitive injuries have a lot to do with joint and limb and total posture. No part of the body acts alone. When one part moves, another is affected. This is especially true of muscles that traverse the same joints. When flexors contract, in order to allow easy movement, the

extensors relax. Muscle control for fine movement (needed for typing) is achieved by a very fine coordination between flexors and extensors (Virginia Hixson., 2011).

Flexicurve

The body posture and angles in the various stages of roti making process of flattening bread on a board using the pin by five Indian women were noted by Flexicurve in the study "The Effects of Stages of Chapati Making and Angles of Body Position on Heart Rate" by Jagjit and Frascille (2007). While making rotis, it was observed that the heart rate was increasing along with variation in body postures which had vast variation.

Grip Strength

The instrument used in order to find out the grip strength of the subject is grip dynamometer. The instrument consists of the handle along the rotating dial with measurement. The handle is to be hold tightly with the other handle present parallel to it and the measurement would be noted in kilograms. Accordingly the reading will be noted before and after the job or work is done. Skie *et al*. 1990; Armstrong *et al*. 1997 had given the calculation thumb to find out the grip fatigue of the subject or the user.

Grip strength in % = Sr-Sw/Sr X 100

Sr – Strength of muscles in rest

Sw - Strength of muscles in work

By this one can know the fatigue of the grip of the subject as how much the strength is been reduced or gained. The main function of the hand is to hold things and perform the activity. In order to hold any of the object or anything the thumb and fingers oppose to give an appropriate grip to the hand enough to hold (German Sports Scientist Weinick, 1990). According to this, we can understand that hand anatomy is rotated around the flexion and the extension comparatively towards more to flexion. The studies show that the flexor motion muscles grip is more strong (62%) enough than that of the extensor (Li *et al*. 2001)".

The study done by Goh et al. (2001) which was on the effect of one night sleep depression and harmonal characteristics and conductivity or performance showed that there is a vast variation in the grip strength of the user from time to time in a day during different activities. It shows that there is a good grip strength power of the person during the day and simultaneously get decreases during the night which effects the harmones of the person and mainly to the endocrine function which releases B-endorphin levels in urine. This makes the difference in the grip strength variation of the user (Cappert, 1999).

The review shows the relation between the elbow positioning and the flexion postures. If there is a less movement of flexion near the elbow part, the grip strength of the person will be higher or greater (Kuzala and Vargo, 1992., Momiyama *et al*. 2006 and Su *et al*. 1994). The anthropometry of the human weight, height, and circumference of palm length, finger length – all these also lead to an increase or decrease of grip strength of a person in one way or the other. A study of Visnapuu and Jurimae (2007) shows that there is positive relationship between the grip strength of the variable and also the different age group people.

Fry et al. (2006) and Smith et al (2006) found in their study that there is a great significance correlation between very elderly and elderly female of overall body strength and grip strength and very slight correlation in between the

populations of elderly and very elderly female of body strength and grip strength. The authors showed the correlation between the physical strength, dietary aspects, fatigue etc.

In the study of Jason Shea (2011), he reported in his research named "Importance of Grip Strength", that from the dietary and nutrition aspects, the hand grip strength can be assessed and analyzed by using the dynamometer in a simple method which is a cost effective and energy efficient tool. Many more studies had been carried out in relation to the correlation of the grip strength of the variable to its overall body strength, body length, height, weight, functioning, nutrition status and importance of the grip strength which effects the proper ergonomical considerations of the tool.

Energy Consumption and Heart Rate

The instrument used for measuring the heart rate is heart rate monitor. It is measured in beats per minute. Subjects heart rate is recorded before performing the task for 5 minutes by giving a gap between 1 minute each. After that the heart rate is recorded while performing the task by the subject for 5 minutes by giving a gap between 1 minute each in between. As the five values which is recorded for 5 minutes at each 1 minute interval while performing the task and taking rest, the average has to be done.

Average Heart rate = Average working Heart rate – Average resting heart rate

Varghese et al. (1989) study on "Workload and perceived Exertion in Household work has termed roti making as a moderate activity with 96 ± 0.64 heart rate and 1.0 ± 0.0 rating of perceived exertion on Borgs RPE Scale. In another study by the same authors has shown that roti making in standing posture requires more energy than in sitting posture (84 to 110 and 101 to 130 heart beats per minute in sitting and standing posture respectively).

The well designed kitchen tools or any equipment with less time consumption and more efficiency of work makes the user comfortable, pleasant and happy and it also increases the interest of the user to perform the activity in all aspects. It improves the quality of life of the person as the human gets satisfied with the equipment they use it gives both physical and mental satisfaction improving the health of the variable maintaining the energy levels as reported by Richardson *et al*. (1985). A study carried out by Grandjean (1973) revealed that there will be a certain increase in the energy consumption levels at household work upto 3-4 kilo calories/Sq.m/min due to the adoption of the unergonomical or improper postures. As a proper posture of adoption while performing activity lessens the more energy consumption (Steidle and Bratton, 1968).

A study on kitchen knives ergonomic evaluation by Dargar (1992) selected the heart rate as a parameter for measuring the physical stress of the subjects while performing the activities using knife. Sandhu (2003) opined that the subject using the sitting posture for masking rotis or Indian breads make the subject more tired and time consuming in Indian kitchen. He reported that when person standing at 2'6" height for making chapattis, the subject is saving 26 percent of his /her energy levels when compared to that of the sitting posture.

Gurushree *et al*. (2011) in their study on "Design, Development and Performance Evaluation of Chapatti Press cum Vermicelli Extruder", developed a chapatti maker, chapatti press including the vermicelli extruder as a multipurpose device. By the mechanical pressing, the texture of the dough and the quality of the chapatti will not be changed which was revealed in the sensory evaluation. In the roti making process, the difference between the manual making of chapatti and use of mechanized tool for making chapatti- the time consumed is 17 times more for manual making compared to mechanized tool. Combined machine produced more numbers of chapatis as machine press time per chapati was 12 times

compared to 29 times of manual sheeting time. The observed variation in 1.5 mm thickness and 173.8 mm diameter from chapati to chapati was of the order of ± 0.1 mm and 1.93 mm respectively. Pressed chapati repeatability results indicated that there was no significant difference in diameters of the samples. Appearance quality characteristics scores of 8 and 7 for 2 mm and 3 mm diameter vermicelli respectively indicated smooth and uniform surface characteristics. Sensory evaluation of the cooked vermicelli indicated no significant difference ($p>0.05$) between 2 mm and 3 mm diameter vermicelli. Cooked weight (72.8 g) and water absorption (191.2%) of 2 mm diameter vermicelli was more compared to 3 mm diameter vermicelli (51.75 g, 107%). This machine can also be used as a laboratory model as products of consistent thickness and diameter were obtained.

CONCLUSIONS

The review which was discussed above clearly shows that the proper correlation between the hand and the hand held tools should be positive which makes the work efficient and appropriately carried out. It shows that there should be a positive high significant correlation between the hand too, grip strength of the user, flexion, extension of the user, physiological stress and psychological stress. A better tool should be designed with the considerations and anthropometry of the user, the grip strength and heart rate should be in a normal condition while performing the task as the tool is designed with ergonomical aspects considerations in all aspects. Many reviews on the hand tools shows that a tool should designed properly considering the ergonomics point of view in all the aspects in order to avoid both physical and mental hazards of the of the user.

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